Automated Monitoring System for Fluid Level and Density in High-Level Waste Tanks

Technology Need:

The Department of Energy (DOE) has over 300 underground storage tanks (USTs) that contain radioactive and chemical mixed waste generated from weapon materials production. Many of the USTs at Hanford have exceeded their life expectancy and a number of them are believed to be leaking. The tanks are closely monitored both inside and out for waste stability, leaks, and releases of materials. Stratification of the waste contents makes it difficult to monitor tank content levels for anything but the uppermost layer of the stratified contents.

There are also a large number of tanks within the DOE complex that are used during processing and handling of waste from DOE clean up operations. Current methods of monitoring fluid and interface levels and density are slow, expensive, provide limited data and, in some cases, may expose personnel to radioactive and hazardous materials and conditions. The need exists for improved technologies to significantly reduce the cost and complexity of monitoring fluid levels and density in waste and process tanks.

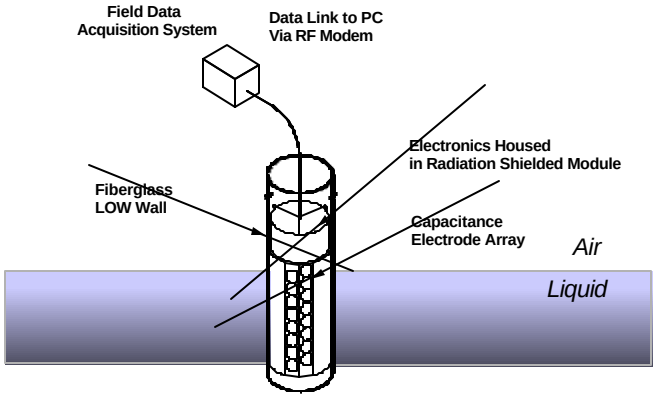
Technology Description:

Science & Engineering Associates, Inc. (SEA) has developed a real-time continuous capacitance and acoustic based monitoring system for measurement of waste fluid levels and fluid densities in DOE waste and process tanks.

SEA's approach is called the Science & Engineering Associates liquid Level monitoring system, or SEAlevel™ system. The system is comprised of either an array of capacitance or acoustic sensors coupled to a data acquisition system. In a typical application the array is lowered into an existing liquid observation well (LOW) through a sealed conduit such as a fiberglass, steel, or PVC pipe. Electrical leads from the sensor array are routed through the pipe conduit to a data acquisition system, which analyzes and stores data from the array.

The detection element of the SEAlevel™ system consists of multiple sensors that form an array covering a length of LOW pipe. Two types of sensors were tested in Phase I: 1) capacitance sensors and 2) acoustic transducers. With the capacitance SEAlevel™ approach, each sensor element in the detector array is comprised of two electrodes (an inner and an outer electrode) that have a loosely coupled electric field between them.

Any conductive or high dielectric material (such as the saturated salt solutions within the tanks) that comes in proximity to the electrodes disturbs the electric field lines and thus changes the response of the sensing circuit connected to the electrodes. Liquid level measurements with the sensor are accomplished by placing the electrodes against the inner wall of a fiberglass LOW. Therefore, the electric field lines will penetrate the LOW wall and will respond differently if there is air, salt cake, or liquid on the outside of the LOW pipe. An array of these sensors,



Configuration of SEAlevel™ sensor ray in a LOW

approximately two feet long, would be used to monitor relative changes of interstitial liquid levels.

With the acoustic SEAlevel™ approach the sensor array would be comprised of piezoelectric ultrasonic transducers. The transducers are used to launch a longitudinal wave into the LOW wall and then measure the reflected signal from the interface between the LOW wall and the tank waste. The magnitude of the reflected wave varies according to the waste material. Thus, the difference between liquid and solid waste on the outside of the LOW can be differentiated. For applications at SRS, the setup is slightly different since the sensors can be configured to be in contact with the tank waste.

Radiation shielding will be provided to protect the electronics package associated with the sensors. The sensor array is lowered into the LOW and coupled to the data acquisition system on the surface via cabling. Using the SEAlevel™ system, the interstitial liquid level in each tank can be measured as often as desired.

Benefits:

<Provides virtually continuous monitoring of interstitial liquid levels as compared to periodic measurements

<Real-time measurement would promptly alert site personnel to changes in fluid levels and densities

<System design would permit implementation through existing LOWs or access conduits in tanks at Hanford, SRS or other DOE sites

<The SEAlevel™ system would provide acquisition of more comprehensive data at a lower cost

<Reduced worker time in tank farm and exposure to radiation fields

<With SEAlevel™ no vehicles are required to drive on top of the tanks and around the tank risers, thereby reducing the risk of damage to the tanks

Status and Accomplishments:

This project was concluded in January 2000. During Phase I, two different approaches were investigated to address four different DOD site applications. For Phase II it was not feasible to build both types of sensor packages and demonstrate them for all applications. It was decided to redirect Phase II efforts to meet a SRS need to monitor the total-suspended-solids content as a function of depth in their waste staging tanks as part of their DWPF processing. During Phase II, the end-user at SRS determined that they no longer have a need for this technology. Due to this, SEA ceased work on designing and fabricating a system to meet this need.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 279
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

For more information on this and other technologies, please visit SEA's website at http://www.seabase.com